Country risk, capital flows and industrial structure: South Africa in the 1990s

Research Notes for Small Group 1

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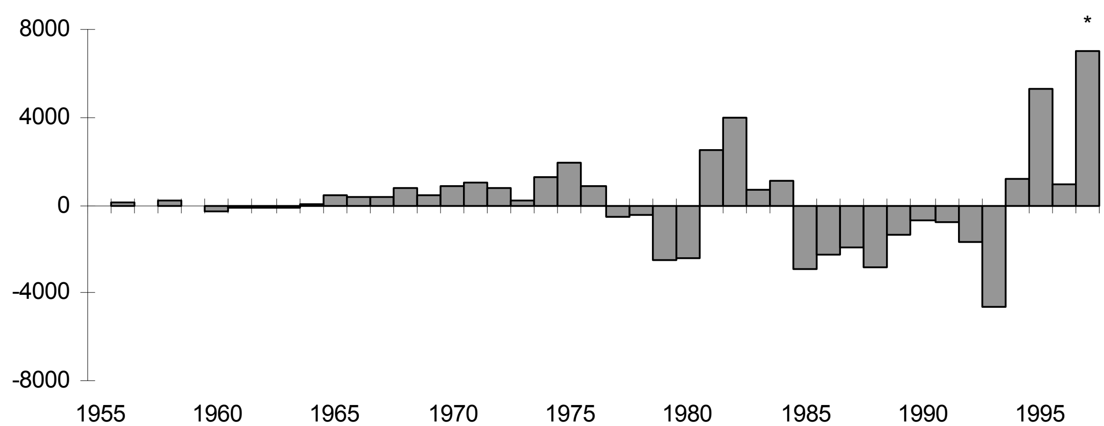
Background

South Africa has undergone a great deal of political change during recent years. One result of this change has been to affect the attractiveness of the investment climate within South Africa. This experiment is designed to examine how a change in the investment climate affects the domestic economy and other economies.

As a result of political changes and uncertainties, investors have shown widely varying degrees of confidence in South Africa's prospects over the last few decades. Figure 1 shows South Africa's annual net international capital flows since 1960.

Figure 1: South Africa's net capital flows (nominal $m)

South



Source: generated from Reserve Bank of South Africa.
* Figure for 1997 is for first half-year, annualised.

It can be seen that losses of investor confidence occurred in the early 1960s, the late 1970s and the period between 1985 and 1993. On each of these occasions, loss of confidence has stemmed from changes and uncertainties associated with the apartheid political system, and the implications of these for South Africa's current and future economic performance. In the period following World War II, existing segregation laws were strengthened and new ones promulgated, and the 'apartheid' system came into existence. Internationally, these met with disapproval but South Africa's most important trading partners, Britain and the US, generally resisted putting economic pressure on South Africa, so those sanctions which were imposed were of only limited effectiveness. South Africa was expelled from the Commonwealth in 1961.

Within South Africa, there were periodic episodes of large-scale overt civil unrest, notably Sharpeville in 1960 and Soweto in 1976. Although these episodes were generally short-lived and geographically confined, they are likely to have had a substantial effect on investor confidence. Economic factors unrelated to political conditions in South Africa may have also contributed to these losses in confidence (particularly commodity price fluctuations) but it is clear that losses of confidence were at least partly due to political factors and their associated economic effects.

The loss of investor confidence since the mid-1980s was the result of a number of factors which arose in opposition to the system which existed at that time. These factors were both internal (including strikes and civil unrest) and external (including trade boycotts and bans on direct investment). As well as having immediate effects on economic outcomes, these factors also portended an uncertain future for the South African economy. Stability and certainty are key factors in investment decision-making, and these were absent from South Africa during this period. Between 1985 and 1993 South Africa experienced a steady outflow of capital. CREFSA (1996) discuss this 'pre-transition' period in more detail.

This situation ended in 1994 when a peaceful and apparently lasting solution to South Africa's political conflicts was found. Since then South Africa has enjoyed strong net capital inflows. In addition, the credit rating assessments made by various agencies have become more favourable. The transition to democracy had a number of effects, including the following:

- elimination of negative impacts on the global operations of companies as a result of investment in South Africa,
- removal of potential source of political instability,
- improving the economic outlook for South Africa, and
- improved relations between South Africa and other African countries providing countries investing in South Africa more access to other African markets.

In this paper, we focus only on the most recent shift in investor confidence, namely that occurring since 1994. We aim to contrast the state of the capital account, and the economy as a whole, before and after this change. All of the effects of the transition to democracy listed above will be positive for investor confidence.

As well as this transition, the South African economy has undergone many policy changes in the 1990s, including significant changes to financial market structure (these are discussed by CREFSA, 1996). Disentangling the individual effects of each change is problematic, and we aim only to assess the impact of changes in investor confidence. The modeling approach used herein is simply to *assume* that investor confidence improves, and then to examine how this affects the capital account, and the economy as a whole.

The sections in this paper are organised as follows: First the way in which GTAP models investment behaviour is described, and various methods by which changes in investor confidence can be captured by the model are explored. Following that, an experiment is designed, and the results of that experiment are analysed. We examine the effects on the South African economy and the 'rest of southern Africa' economy in detail, looking at impacts on investment, on product markets and on factor markets.

Methodology

Data aggregation

The exercise uses a uses a 5 region and 7 commodity aggregation of the GTAP data base. The regions and commodities are as follows:

Regions

- South Africa (SAFRICA)
- Rest of Southern Africa (RESTAF)
- Rest of Sub-Saharan Africa (RESTSSH)
- European Union (EUNION) and
- Rest of the World (RESTWLD)

Commodities

- Agriculture (AGRIC)
- Natural resources, extractive and related industries (EXTRACT)
- Food manufacture (FOOD)
- Unskilled labour intensive manufacturing (LITMNFC)
- Skilled labour intensive manufacturing (TECHMNFC)
- Capital intensive manufacturing (HVYMNFC) and
- Services (SVCES).

In the GTAP data, South Africa really refers to the South Africa Customs Union member countries, consisting of Lesotho, Swaziland, Botswana and South Africa itself while rest of southern Africa relates to Angola, Malawi, Zambia, Tanzania, Zimbabwe, Mozambique and Mauritius.

How capital is modeled in GTAP

In GTAP, in addition to a number of tradeable commodities, there is a commodity called 'capital goods' CGDS which is not tradeable. While the tradeable commodities correspond to normal definitions of industries and products, CGDS does not. It is a notional sector which does not undertake any real economic activity of its own. It does not employ any primary factors of production (land, labour, capital), and its value-added is therefore zero. The sector is used to combine the various inputs to investment expenditure (e.g. construction services, fabricated metal products, machinery, etc.) into one composite commodity, CGDS, which is then purchased by investors (represented in the model by an institution called the global bank). Both imports and domestic goods can be used as inputs into the sector. Because CGDS itself is not tradeable, the amount of CGDS produced in a country must be equal to, and is determined by, the amount demanded by the global bank in that country. The commodity is akin to the 'investment' column of an input/output table rather than one of the productive sectors.

It is useful to separately consider two aspects of the capital goods sector: How total spending on capital goods is determined, and how this total is spread across regions. These two aspects are discussed in the following two sub-sections.

Total spending on capital goods

GTAP is a comparative static model. It reduces the dynamic process of capital to the annual snapshot which the database represents. Investment is generally motivated by the possibility of profits in the future. Future profits are represented in the model through the regional household's utility function. Current savings provide utility in the current period precisely because they offer the promise of future returns. These savings translate immediately into investment and hence purchases of capital goods. So money devoted to savings must be spent on the capital good (global S = global I). Implicitly, this treatment is motivated by the recognition that spending on the capital good does provide future benefit. Savings are modeled simply as a fixed proportion of total household income. Total spending on capital goods, therefore, depends only on how incomes change. This means that any changes which may occur to the (global) productivity of capital, agents' rates of time preference, or other factors which may influence decisions on levels of saving cannot be directly represented in the model, and thus cannot be used to explain changes such as that which have occurred in South Africa.

Allocation of capital spending across regions

Although total savings determines total investment, the allocation across regions of expenditure on capital is decided by the 'global bank'. The bank receives savings inflows from households in all regions, and given the size of these inflows, decides how best to allocate its total funds across regions. It purchases real as opposed to financial assets. In this sense the global bank is somewhat analogous to the aggregate of all multinational corporations deciding where to build new plants plus all the other intermediaries moving capital for investment in real assets (as opposed to financial assets).

As regards the decision-making process of the global bank, GTAP allows for the operation of either of the two processes. The first, and simplest, process involves preserving the relative shares of global investment which are spent in each region. In this case if total savings goes up by a certain proportion, investment spending in each region will go up by an identical proportion.[1] In the current experiment, this structure is not used, because it does not allow for any change in the relative attractiveness of different regions. The second process which the global bank can use involves maximising the rate of return on that investment. For present purposes, this is a more suitable process, as it allows the bank to shift investment between regions as they become more or less attractive.

'Attractiveness' depends on expected future returns and risk. As mentioned above, GTAP does not explicitly look forward into the future, and so does not provide a robust basis for determining future returns, and how these may change. To provide a basis for this process, it is hypothesized that expected returns in a given region will fall as the amount of investment undertaken in the present rises (see Hertel and Tsigas, 1997, pages 54-60). The strength of this relationship depends on the value of the parameter RORFLEX (which may vary across regions, but does not in this experiment). Further, it is assumed that the initial distribution of investment represents an equilibrium not in the sense that actual rates of return are equalised across all regions, but in the sense that any differences between rates are accountable for by (unobserved) differences in riskiness.

This means that the global bank, when faced with a change in the total amount of money it has to allocate across regions, or a change to the expected rate of return in any region, will adjust the allocation of investment in such a way that risk adjusted rates of return across regions are equalised. This structure turns out to be amenable to modeling a change in the investment climate.

Limitations

The focus of this study is the effects of capital flows on the composition and direction of trade in the medium run. The influence of changes in investment will be on the demand side: the trade balance changes, and the pattern of domestic demand changes. While it is very well-suited for examining how capital inflows affect each sector of the economy, GTAP (or any other comparative static GE model) is not well-suited to assessing the long run impacts of capital flows. In the long run, the most important effects are on the size of the capital stock and on productivity, which are not captured by the GTAP framework.

Because of these limitations, this experiment is unable to determine conclusively how capital inflows affect South Africa long run. This should be borne in mind when considering the results. One particular implication of this is that welfare analysis does not provide a robust indicator of whether the economy will

[1] This is represented in the model by setting the value of the RORDELTA parameter to zero.

eventually benefit from capital inflows. For this reason, in the analysis section, we focus on the medium-

Rationale

It is assumed here that the sum of the various effects on the investment climate in South Africa mentioned above can be treated as a reduction in the risk premium which the global bank attaches to investment in South Africa.

Derivation

Explicit data showing South Africa's risk premium are not directly available. However, changes in riskness can be modeled in a *de facto* way by the *cgdslack* variable, which enters the model as follows in the case where *RORDELTA* = 1:

(1) $rore(r) = rorg + cgdslack(r)$ (from equation 11', Hertel and Tsigas, 1997)

This equation states that the percentage change in the rate of return on investment in region *r*, *rore(r),* is equal to the percentage change in the global rate of return, *rorg*, plus some extra factor which is generally exogenous and set at zero in a general equilibrium closure. Normally, the *cgdslack* variable is only non-zero when we allow the market for capital goods to not clear. However, *cgdslack* can also be used to represent a risk premium. This is shown as follows:

We first assume that the global bank equalises expected risk-adjusted rates of return, so that risk-adjusted rates for all regions are equal to some global average.

$$(2)\quad \frac{\text{RORE(SAFRICA)}}{\text{RISK(SAFRICA)}} = \frac{\text{RORE(RESTSAF)}}{\text{RISK(RESTSAF)}} = \frac{\text{RORE(EUNION)}}{\text{RISK(EUNION)}} = \ldots = RORG$$

Here, the *RISK(r)* represents the ratio of equilibrium returns in region *r* to the global average rate of return. For risky countries, this ratio will be above 1, and for safe countries below 1. It is important to note that this variable represents a ratio rather than a certain number of percentage points - it is better called a 'risk ratio' than a 'risk premium'. Also note that *RORG* does not represent a riskless return but a weighted average of returns around the world. This formulation differs from the more familiar representation of required rate of return in a country being equal to the riskless return plus some margin.

If we rewrite this as

(3) $RORE(r) = RORG.RISK(r)$

then by total differentiation and division through by *RORE(r)* we can obtain

(4) $rore(r) = rorg + risk(r)$

which is the analogue of equation (1) above, with $cgdslack(r) = risk(r)$.

Thus, although *cgdslack* was not originally designed to be used as a measure of the risk ratio, and has not previously been interpreted in this way, it is suitable for the purpose. Furthermore, in a general equilibrium closure, *cgdslack* is unused for any purpose, and therefore we do not disturb any other components of the model by using it in this way.

As a word of caution, when using *cgdslack* in this way, as well as checking the post-shock value of *walraslack* to ensure a GE closure (it should be zero), it is also necessary that the model closure include *cgdslack* as an exogenous variable, and that the parameter *RORDELTA* be equal to 1 in the parameter file.

Shock selection - theory

Estimating an appropriate-sized shock requires some care because of the particular definition of the risk ratio.

We have

$$(5)\ risk(r) = \frac{dRISK(r)}{RISK(r)} = \frac{RISK'(r) - RISK(r)}{RISK(r)}$$

where the superscript ' denotes the post-change value of a variable.

We do not necessarily have data on the risk ratio. To overcome this limitation in a simple way, it is necessary to assume that a shock to the risk ratio will not appreciably change the global average rate of return (i.e. *RORG'* = *RORG*). This is a reasonable assumption in the present case, as the value of gross investment spending in South Africa in 1995 makes up only 0.4% of the global total.[2] (see base GTAPview data array AG01, column totals)

Using this assumption and equation (3), equation (5) simplifies to

$$(6)\ risk(r) = \frac{RORE'(r) - RORE(R)}{RORE(r)}$$

In order to determine an appropriate shock for *risk(r)* it is necessary to know what the required rate of return in South Africa initially is (*RORE*), and what it changes to (*RORE'*). It is not necessary to know either the global required rate of return or the risk ratio. It is also not necessary to attribute the change in the risk ratio to any particular event or set of events. In this experiment a number of political and economic changes occurred, and we treat the observed change in *RORE* as being the result of the *combination* of all these changes.

Shock selection - practice

Because GTAP is purely a model of 'real' goods, with no financial instruments included, the most appealing measure of required returns would be based on the returns from directly holding real assets. In the absence of appropriate data, we rely on data relating to returns on financial assets. Changes in rates of return on financial and real investments in a given country are likely to be strongly correlated, so a *change* in yield on financial assets may be an acceptable proxy for a *change* in the required yield on real assets, even though the absolute levels differ.

CREFSA (1997) provide a succinct overview of the issues associated with interpreting the various data which are available. They consider yields on bonds to be more appropriate indicators of country risk than yields on syndicated loans, and identify three components of risk which may be manifested in bond yield premiums (over 'risk-free' alternatives):

- country risk,
- currency risk, and
- borrower-specific risk factors (if no government guarantee is involved).

Currency risk is a financial phenomenon which we wish to exclude from our measure of risk. South African debt which is denominated in rand will include a currency risk premium, while South African debt which is denominated in the currency of the lender will not. Thus we prefer the latter. We also prefer to

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[2] In general, if we do not wish to make the 'small country' assumption, then
risk(r) = (RORE'(r)/RORG') / (RORE(r)/RORG) - 1
where *RORG* and *RORG'* are global required rates of return before and after the shock respectively. In this case, *risk(r)* cannot be determined exogenously because *RORG'* is endogenous. Alteration of the GTAP model would be required to accurately reflect this.

exclude borrower-specific risk factors from our measure, and we can do this by looking at data on government-issued or government-backed bonds.

Thus, yields on non-rand denominated government bonds will give a reasonably good proxy for country risk.[3] Figure 1 in CREFSA (1997) shows the premiums which were achieved at the time of issue by non-rand-denominated South African government bond issues between 1991 and 1997. Secondary market yields on these bonds would be useful supplementary data.

We also need to consider what are the most appropriate points in time which can be considered 'pre-shock' and 'post-shock'. Politically, the crux of South Africa's transition occurred in 1994, and the resulting capital market effects occurred immediately following this: In 1994 South Africa experienced a capital inflow for the first time since 1985, and received favourable ratings from various credit agencies. Although the size of the capital inflow was smaller than in subsequent years, it is clear that some effects of the transition were manifested in 1994. Choice of a pre-1994 observation for the 'pre-shock' value, while conceptually correct, creates a problem in interpreting the results.

The database (which is also intended to represent a 'pre-shock' state of the world) is in fact calibrated to 1995, which is after the shock. In the absence of any modifications, this means that the shock is imposed upon the world as it was in that year. The practical effect of this in the present experiment is that the base-year database already shows the impact of the transition, and then another positive shock is imposed on top of this. The best way to overcome this problem would be to use a database whose base year pre-dates 1994. With a base year of 1992, version 3 of the GTAP database is one such database, but unfortunately it does not identify South Africa as a separate region. Another method, which is not employed here, is to recalibrate the model so that certain variables (in particular, South Africa's capital account position) better match the pre-1994 situation. In the absence of either of these two methods, the absolute levels of several relevant variables are implausible – it is as if South Africa experienced *two* positive shocks instead of one. However, we are still able to examine percentage changes in variables with a fair degree of confidence.

Of the bonds issued, those which seem most clearly to represent 'pre-shock' and 'post-shock' observations, and to be reasonably comparable in other respects (currency, size of issue and maturity) are the Deutschemark bond issues of September 1991 and September 1996.[4] The premia on these two issues were 240 and 140 basis points respectively (100 basis points = 1 percentage point). To calculate RORE and RORE' we also need to know the 'risk-free' yield on DM-denominated debt, i.e. the yield on comparable-maturity bonds issued by the German government. We assume this to be 5%. We can use Equation (6) to calculate the necessary shock:

$$risk(SAF) = \frac{RORE'(SAF) - RORE(SAF)}{RORE(SAF)} = \frac{(1.4+5.0)-(2.4+5.0)}{(2.4+5.0)} = -0.135 = -13.5\%$$

We therefore shock the value of *cgdslack* in South Africa by this amount. For all regions other than South Africa, no change to the risk ratio occurs, and no shock to *cgdslack* is required.

Alternative possibilities

Initially, three alternatives experiment designs were considered. The risk ratio method described above was chosen over the alternatives because it is a comparatively direct way of modeling the effect which we wish to analyse, and because it has the attractive property of preserving the GE nature of the model. The other two methods are described below.

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[3] If capital markets are not able to clear, then actual yields may not accurately reflect risk premia. The fact that, to a greater or lesser extent, capital controls existed throughout the period in South Africa indicates that some caution is warranted in using this approach.

[4] The second of these, in fact, effectively refinanced the first.

Trade balance shock

An increase in investment in South Africa without a corresponding increase in domestic savings requires an increase in the capital account surplus, and this must be matched by a corresponding increase in the trade account deficit (S – I = X – M). One means of imposing this outcome on the model is to make the trade balance *DTBAL* exogenous, and to shock this in a negative direction. This is an indirect method of achieving the effect which we wish to model.

However, *DTBAL* cannot be exogenised in a satisfactory way in the present case. Normally, if *DTBAL* is exogenised, either *saveslack* or *cgdslack* is endogenised. If *saveslack* is endogenised in this case, then any shock to the trade balance will be reflected in savings. This is not the effect which we wish to have occur.

If *cgdslack* is exogenised, then the shock will be reflected in investment. If this is done, however, the closure is no longer a GE one (*walraslack* is non-zero).[5] This means that we also need to 'swap' *walraslack* and *PSAVE*, which in turn leaves us with no numeraire price. A different price can be fixed as the numeraire, but this requires that the market to which price pertains to fail to clear, which is not desirable. Overall this method, while not impossible to implement, has little to recommend it.

Direct shock to investment

The most direct way to simulate an increase in capital inflow is to exogenise and positively shock the quantity of capital goods supplied *qcgds* in South Africa. To do this creates a similar problem to that encountered in implementing the trade balance method, however: When this is done, *walraslack* is non-zero, and so *psave* is endogenised. After this, the model has difficulty solving, presumably because of the lack of a numeraire price. Consequently this does not appear to be an attractive method.

Results

Effects on the South African economy

Capital goods sector

What happens in the model when the perceived risk of investing in South Africa falls? The immediate effect of a negative shock to *cgdslack("SAFRICA")* is to increase the value of the ratio RORE("SAFRICA") / RP ("SAFRICA") (remember that the percentage change in RP is equivalent to *cgdslack*). Equilibrium requires that this ratio remain unchanged, and equal to the global average risk-adjusted rate of return *RORG*. How is this achieved? Because the risk ratio *RP* is exogenous, the expected rate of return *RORE* in South Africa must fall. Because of the assumption built into the model that the expected rate of return is inversely related to the level of investment, this is achieved by increasing the amount of investment in South Africa. Intuitively this is just the result we would expect.

The result of the experiment is that the quantity of investment goods 'produced' increases by 35.9%, see table 1.

Table 1. SAF Capital Goods Sector

	Pre-shock	Post-shock	Source:
Gross Investment (US$ bn)	26	36	View base & updated data GTAPview(baseview) AG01, SAFRICA
Depreciation (US$ bn)	19	19	View base & updated data basedata, VDEP, SAFRICA

[5] The reason why exogenising CGDSLACK destroys the GE nature of the closure, but exogenising SAVESLACK does not, has not been resolved.

Net Investment (US$ bn)	7	17	View core and updated data AG01-VDEP
Change in Quantity (%)	N/A	35.9	Results, vector elements, SAFRICA, qcgds
Change in Price (%)	N/A	4.9	Results, vector elements, SAFRICA, pcgds

Direct demand growth

To achieve the increase in capital goods output, it is necessary to increase the purchases of inputs by that sector. We can gain some idea of where these inputs will come from by examining the pre-shock inputs into South Africa's capital goods sector in table 2.

Table 2. Pre-shock Sources of Inputs to SAF Capital Goods Industries (US$ mn)

	Values		Shares		
	Domestic	Imported	Domestic	Imported	Total
AGRIC	1	0	100.0%	0.0%	0.0%
EXTRACT	0	8	0.0%	100.0%	0.0%
FOOD	0	0	n/a	n/a	n/a
LITMNFC	48	1	98.0%	2.0%	0.2%
TECHMNFC	6013	6384	48.5%	51.5%	48.6%
HVYMNFC	133	6	95.7%	4.3%	0.5%
SVCES	12895	20	99.8%	0.2%	50.6%
Total	19090	6420	74.8%	25.2%	100.0%

Source: core basedata array VDFM and VIFM, REG=SAFRICA, COMM=CGDS

The last column shows that total inputs come in approximately equal shares from the services sector (which includes construction) and the high-tech manufacturing sector. The third and fourth columns show that, services are almost entirely domestically sourced while high-tech manufactures come in approximately equal shares from domestic and foreign sources.

The capital goods industry (like all other industries in the model) does not substitute between different intermediate inputs. Therefore, the percentage growth in demand for input from each sector will increase by the same amount as the growth in output. However, there is input substitution between domestically produced and imported commodities. Hence, the balance of inputs from the high-tech manufacturing sector may change, depending on how relative prices of the imported and domestic products change. As will be discussed below, the relative price of domestically produced manufactures will tend to rise, and as a result its share (in volume terms) will tend to fall. The domestic share in the pre-shock economy is 48%, and this falls to 45% after the shock (these are calculated from *VDFM(Techmnfc,CGDS,SAFRICA)* and *VIFM(techmnfc,CGDS,SAFRICA)* in the base and updated core data sets).

Volume changes of the various inputs into the capital goods industry in South Africa are as follows:

Table 3. Capital Goods Sector Input: Volume Changes (US$m)

	Domestic	Imported
TECHMNFC	1347	3128
SVCES	4625	11
All Others	64	7

Source: Results view updated data "volume changes",
Dom.=DQFD (SAFRICA, CGDS)
Imp.=DQFM (SAFRICA,CGDS)

Thus, the direct result of growth in the capital goods industry is an increase in demand for domestic services and high-tech manufactures, and an increase in demand for imported high-tech manufactures. The extent to which each of the two sectors is affected depends on the proportion of its output which goes to the capital goods sector.

Table 4 shows the proportions of output of each commodity which are sold to each different type of user. The second column shows the share of each commodity's output which goes to the capital goods sector. Although the capital goods sector demands twice as great a value of services inputs as high-tech manufactures inputs, the latter makes up a greater proportion of the sector's outputs. This is because the services sector is much larger than the high-tech manufactures sector. Expansion of the capital goods sector has little direct effect on the other sectors.

Table 4. Disposition of Output of SAF Industries (%)

	Intermediate	CGDS	Final cons.	Exports
AGRIC	59	0	26	16
EXTRACT	35	0	12	52
FOOD	28	0	66	6
LITMNFC	46	1	38	16
TECHMNFC	44	25	19	12
HVYMNFC	66	0	9	24
SVCES	40	9	48	4
Total	44	7	38	11

Source: basedata GTAPview output array CM01, row shares.

Note: 1. Expressed as % of total sectoral output.

2. Private and government consumption is combined.

Note that it is not possible to verify these statements by examining the state of the economy after the shock (as represented by the updated data set) as it will be affected by both direct and indirect effects of the shock. We also need to consider indirect effects of the shock, before we can come to any conclusions as to how each sector will ultimately be affected.

Factor market effects

Because the capital goods industry does not directly employ primary factors of production, there are no direct effects on factor markets. Expansion of the services and high-tech manufactures sectors will require that these two sectors purchase more primary factors. The sectors may not substitute intermediate inputs for primary factors although they may substitute amongst the five primary factors. Increases in demand will be most marked for those factors which are used relatively intensively by the two sectors.

Table 5 shows the direct factor intensities in South African industries prior to the shock. Services use skilled labor intensively compared to other sectors, while high-tech manufacturers uses capital intensively compared to all other sectors except heavy manufacturing. Neither sector uses land, natural resources or unskilled labor intensively. This means that the direct effects of the shock will put most upward pressure on prices (wages) of skilled labor and capital, see table 6.

Table 5. Direct Factor Intensities in SAF (%)

	Land	UnskLab	SkLab	Capital	NatRes
AGRIC	15	39	1	45	0
EXTRACT	0	33	6	32	30
FOOD	0	47	10	44	0
LITMNFC	0	64	10	26	0
TECHMNFC	0	43	9	48	0
HVYMNFC	0	40	9	52	0
SVCES	0	40	26	34	0

Source: core basedata array EVFA

Note: % of total primary factor use by sectors.

Land is used only by the agricultural sector, and natural resources are used only by the extraction sector. Both of these sectors provide very little input into the capital goods sector, and so there will be no direct effects on the factor prices of land or natural resources.

Table 6. Changes in Factor Prices

	% Change
Land	-12
UnskLab	8
SkLab	10
Capital	8
NatRes	-13

Source: Results PS(*,SAFRICA)

Supply prices

Output prices for high-tech manufactures and services will rise because of the increase in demand for these goods. Output prices of other industries will also be affected by the changes in factor prices. Because industries operate under zero-profit conditions, any increase in input prices is reflected in output prices – producers have no capacity to absorb any changes in input prices. Apart from high-tech manufacturing and services, output prices will tend to rise most in those sectors which intensively use skilled labour and capital – the food processing sector and heavy manufacturing sectors use both, while agriculture uses capital intensively, see table 7.

Table 7. Output Price Effects in South Africa

PS(SAF)	% Change
AGRIC	4.87
EXTRACT	2.97
FOOD	5.45
LITMNFC	5.69
TECHMNFC	5.94
HVYMNFC	6.27
SVCES	7.03

Source: Results PS(SAFRICA)

Trade effects

All tradeable commodities produced by South Africa compete with commodities produced elsewhere. Changes in the output prices of South African products will affect how price-competitive those products are, both on the South African market and elsewhere. Price rises will result in reduced demand. The extent to which each industry is negatively affected by price rises depends in large part on the extent to which it is exposed to competition from foreign-sourced goods.

Table 8. Trade Exposure of South African Industries
(as % of domestic output)

	Exports	Imports	Total
AGRIC	16	9	25
EXTRACT	50	23	73
FOOD	6	7	12
LITMNFC	16	20	36
TECHMNFC	12	59	71
HVYMNFC	24	16	41
SVCES	4	4	8

Source: base GTAPview AG05 exports and import arrays, and output array CM03.

The structure of demand for goods in GTAP is a two-stage one: consumers determine the proportion of total demand for a good which will be imported, and choose the proportions of imported goods which will come from each different source. Because of this structure, the elasticity of demand for a domestically-produced good will generally be lower than the elasticity of demand for an imported good from a particular source.

As a result of this demand structure, for example, South African goods cannot easily be displaced by European goods on the South African markets, but they can be displaced much more easily on New Zealand markets because New Zealand consumers do not distinguish South African and European goods as clearly as do South African consumers. This means that not only gross trade exposure determines how great an effect on demand a price rise has, but also the pattern of that exposure. For a given price rise, exporters tend to be harder hit than those competing with importers on the domestic market. This occurs because importing countries have the option to source from different regions

This can be demonstrated by examining the elasticities of substitution, which vary between commodities. Elasticities of substitution between the domestic commodity and the bundle of imported commodites (*ESUBD*) are shown in table 9. It is important to note that these are elasticities of substitution, not elasticities of demand. Demand for exports can broken up into many different sources. In order to determine overall export elasticities, it is necessary to run a simulation. However, for a relatively small country (like South Africa) the elasticities of demand facing exports will be approximately equal to the parameter *ESUBM*, which is set at twice the level of *ESUBD*.

Table 9. Elasticities of Substitution for Domestic Commodities

	Substitution Elasticities
AGRIC	2.4
EXTRACT	2.5
FOOD	2.4
LITMNFC	3.2
TECHMNFC	3.4
HVYMNFC	2.2
SVCES	1.9

Source: Parameters Text array ESUBD

Overall, therefore, the extent to which output in each South African industry declines depends on three factors: how much the price of the commodity rises; how exposed to foreign competition the commodity is; and whether this exposure is predominantly on the domestic market or overseas. The commodities with the greatest price rises are services and all manufacturing, while the commodities most exposed to trade are extraction and high-tech manufactures. Light and heavy manufactures also have a significant trade exposure (see table 8).

Final consumption

Higher factor prices provide the regional household (which owns these factors) with a higher level of nominal income (in the results page, *y* increases by 8.5% in South Africa). However, prices in the South African economy will also tend to rise (in the results page, *pgdp* rises by 7.3% for South Africa), which means that household's real income level will rise by less than the increase in factor prices (the best measure of real income is the variable *u*, which rises by 2.4%). As a result, households demand more consumption goods and savings (in value terms, demand for consumption goods and savings will increase by the same proportion, because of the Cobb-Douglas utility function). This effect favors those industries where income elasticities of demand are highest.

Indirect inter-industry effects

We have already considered what changes will occur to three of the four sources of demand for South African commodities: The capital goods sector, foreign consumers, and domestic final consumers. We now need to consider how domestic intermediate input demand changes. As noted above, GTAP does not allow substitution between different intermediate inputs. Consequently, the demand for, say, agricultural output by the food processing industry will always change by the same proportion as does the output of the food processing industry (although the share of this demand satisfied by domestically-produced agricultural goods can change). Intermediate demand for any commodity, therefore, will depend on how well the downstream industries do. If the food processing industry contracts, so will intermediate demand for agricultural goods by the food processing industry. To get an idea of exposure of different commodities to changes in production levels and consequent in intermediate demand, we can first look at how great a share of total demand for each commodity comes from other industries (see table 4). We can then examine the pattern of intermediate demands across industries.

Table 10. Intermediate Demand Shares in SAF (% of domestically produced commodities)

	AGRIC	EXTRACT	FOOD	LITMNFC	TECHMNFC	HVYMNFC	SVCES
AGRIC	7	0	84	3	0	3	3
EXTRACT	9	14	2	1	5	20	49
FOOD	15	0	62	3	0	2	19
LITMNFC	2	2	3	47	4	9	33
TECHMNFC	1	4	4	1	14	6	34
HVYMNFC	4	2	7	4	18	33	32
SVCES	2	4	4	2	4	12	54

Source: core basedata array VDFM, SAFRICA, row shares

Note: Shares may not sum to 100 due to none inclusion of CGDS shares (discussed earlier).

Table 10 shows that, for example, 84% of the total sales of agriculture as intermediate good went to the food processing sector. In general, a substantial share of the output of most industries is re-sold to firms in the same industry. Other than intra-industry sales, significant flows and their implications for the output of the selling industry include:

- sales of agriculture to food processing

- sales of extraction to heavy manufacturing
- sales of heavy manufacturing to high-tech manufacturing
- sales from all sectors except agriculture, to services

When the output level of the purchasing industry falls (which is true for the first three of these flows, see table 12) this will have a negative effect on the selling industry, and vice versa.

Summary of effects

Table 11 shows a summary of all the factors which affect an industry's performance, along with the equilibrium response of each industry in South Africa to this shock. A '+' means that the effect in question will tend to increase the sector's output volume, and a '-' means the opposite. These are qualitative indications only, and cannot be combined to indicate the net effect on any sector.

Table 11. Summary of Impact on South African Industries

	Agric	Extract	Food	LMnfc	Tech	HMnfc	Svces
Greater Investment					++		+
Higher prices of capital	-		-		-	-	
Higher price of skilled labour			-	-	-	-	--
High trade exposure	-	--		-	--	-	
Elastic demand				–	–		
High final consumption exposure			++	+			+

We can further explore the effects on each industry by looking at how sales volumes to each of the various demanders change.

Table 12. Sales Volume Changes for South African Industries

	Sales to Cgds	Final Consumption	Exports	Total Output
AGRIC	0.3	49	-271.1	-395.2
EXTRACT	0	54.9	-879.5	-1003.3
FOOD	0	223.7	-228.9	-168.8
LITMNFC	17	-48.1	-425.3	-817.1
TECHMNFC	1346.8	-107.1	-864.4	-495.4
HVYMNFC	46.8	9.4	-1795	-2978.6
SVCES	4625.3	1056.4	-885.5	4056.8

Sources: updated volume changes data arrays DQFD,DQGD, DQPD, DQXS, DQO.

Note that although these are volume changes, they are not denominated in normal volume units (tonnes, cubic metres, etc.) but are denominated for all commodities as the amount which could be purchased at pre-shock prices for one million 1995 US dollars.

Trade balance

In a general equilibrium closure of GTAP, the identity S-I=X-M must hold. Changes in the capital account must be offset by changes in the current account. In this experiment, both savings and investment increase, but the increase in investment is much larger, as this is a direct rather than secondary effect of the shock. This means that the balance of trade must deteriorate. This may be caused by a rise in imports, a fall in exports or a combination of both.

Table 13. Changes in SAF Trade Flows (US$ mn)

	Base Exports	updated Exports	Base Imports	updated Imports	Change Exports	Change Imports	Trade Balance
AGRIC	1626	1418	893	974	-208	81	-289
EXTRACT	6705	6038	3087	3036	-667	-51	-616
FOOD	1123	952	1369	1518	-172	149	-321
LITMNFC	1466	1101	1894	2096	-365	202	-567
TECHMNFC	2905	2160	14113	17969	-745	3856	-4601
HVYMNFC	8584	7225	5804	6268	-1359	464	-1823
SVCES	3863	3189	6741	7737	-674	996	-1670
Total	26273	22082	33900	39598	-4191	5698	-9889

Source: 1. base data exports from base core data array VXWD (*, SAFRICA,sum reg)
2. base data imports from base core data array VIWS (*, sum reg,sum reg,SAFRICA)
3. updated data exports from updated core data array VXWD (*, SAFRICA,sum reg)
4. updated data imports from updated core data array VIWS (*, sum reg,SAFRICA)
Note: Trade balance = change in exports-change in imports.

We can see from table 13 that both effects appear: imports rise and exports fall. It is important to note that while South African trade balance deteriorates in the medium term, this should not be considered a long run effect. In the long run, the motive force for the changes in trade flows (an increase in foreign investment as a result of a decline in risk) will gradually diminish. In addition, South African productivity may increase as a result of the new investment. Neither of these effects are captured in this simulation.

Welfare effects

The most immediate welfare effect in this experiment arises from the increase in demand for South African capital goods on the part of the global bank. This increases income in South Africa which increases utility. The impacts on terms of trade are in principle ambiguous. As shown earlier, export volumes decline, which generates a positive terms of trade effect, while import volumes increase, which generates a negative terms of trade effect. General equilibrium impacts emanating from other regions also influence terms of trade. In this simulation, the export price effect dominates terms of trade effects. Import price effects are actually mildly positive (see the terms of trade welfare decompositions in RunGTAP: View-Updated Data-Welfare Decompositions- array E). Factor endowments and technology levels do not change in this experiment, so no welfare changes will come from these sources.

Table 14: Welfare Effects

	SAFRICA	RESTSAF	RESTSSH	EUNION	RESTWLD	Total
alloc_A1	861.8	-10.3	-23.2	-121.8	-266.6	439.9
endw_B1	0	0	0	0	0	0
tech_C1	0	0	0	0	0	0
uinc_D1	-1.1	0	0	0	0	-1.1
tot_E	1865.3	-118.5	-23.4	-304.7	-1474.6	-55.8
Total	2726	-128.9	-46.5	-426.4	-1741.2	383

Source: Updated welfare decomposition data array A.

Allocative efficiency welfare effects will arise if the pattern of economic activity is shifted away from or towards relatively distorted activities. Without information on the pattern of distortions, there is no strong reason to expect either large allocative gains or losses in this experiment. It is interesting to note that South Africa enjoys a welfare gain as a result of improvements in allocative efficiency. Further exploration of this total shows that the most significant component arises from increased imports of high-tech manufactures from the EU and the rest of the world (see array A231 in updated data welfare). Tax rates on these products are 8% for EU and 13% for the rest of the world. Since the tax rates are relatively small, this allocative efficiency gain is somewhat surprising. Allocative efficiency effects on other regions are relatively small.

The terms of trade improvement which South Africa enjoys is gained at the expense of other regions. (Advanced question: why is the global sum of terms of trade effects non-zero). In particular, the rest of southern Africa suffers a welfare loss. In the next section, we examine in more detail the effects of the shock on that region.

Effects on other Southern African countries

In GTAP, the 'rest of Southern Africa' region *RESTSAF* is made up of Angola, Malawi, Zambia, Tanzania, Zimbabwe, Mozambique and also Mauritius. This region is a synthetic one: It is calibrated to the GDP and trade levels reported by these Southern African countries, but the input/output structure is a synthesis of input/output tables from other regions (India, China and Vietnam).

Effects on industries

According to the GTAP database, trade links between South Africa and the rest of southern Africa are not particularly strong despite their geographical proximity. Southern Africa runs a substantial trade deficit with South Africa. Only 4% of southern Africa's exports go to South Africa, while South Africa provides 21% of the imports to the rest of southern Africa (according to GTAP data). This seems to be because of the fact that the commodities which the rest of southern Africa exports most (agricultural and extracted commodities) are not in short supply in South Africa. The most substantial trade flows between the two regions are South African exports of high-tech and heavy manufactures to the rest of southern Africa. The main impact on the rest of southern Africa of the changes in South Africa will be transmitted *via* these trade flows.

Table 15: Rest of Southern Africa Bilateral Trade with S. Africa

	Exports to South Africa		Imports from South Africa	
	$m FOB	Share	$m CIF	Share
AGRIC	99	0.05	135	0.23
EXTRACT	24	0.01	155	0.47
FOOD	43	0.14	303	0.27
LITMNFC	123	0.08	140	0.12
TECHMNFC	60	0.13	891	0.20
HVYMNFC	58	0.04	997	0.44
SVCES	22	0.01	40	0.02

Source: Core base data arrays VXWD and VIWS. The shares are Rest of Southern Africa's shares in each area.

As shown in (table 11), prices of South African-produced commodities rise following the shock. Due to price increases, exports tend to fall. However, because of the Armington assumption, they will not be completely crowded out. Since South Africa represents a large source of imports for southern Africa, the prices of aggregate imports of these goods (as measured by variable PIM) tend to rise. For example, the price of aggregate heavy manufactures imported into rest of southern Africa rises by 2.4% reflecting price rises in South Africa and the heavy weight of sourcing from South Africa. As a result of changes in import prices, prices of domestically-produced commodities are impacted. Table 16 shows the equilibrium changes to prices in the rest of southern Africa.

Table 16: Price changes in the Rest of Southern Africa

	Imports SAFRICA	Imports All	Goods All
AGRIC	4.34	0.85	-0.06
EXTRACT	2.64	1.18	0.07
FOOD	5	1.21	0.22
LITMNFC	5.33	0.56	0.14
TECHMNFC	5.63	0.94	0.4
HVYMNFC	5.83	2.36	0.29
SVCES	7.03	0.07	-0.12

Sources: pcif, pim, pm from results file.

Output levels in the rest of southern Africa will be affected by a number of factors, including:

- Increase in import demand from South Africa
- Improved competitiveness vis-a-vis South African products (in both regions, and on third-country markets)
- Reduced demand form the shrinking capital goods sector (see the following section)
- Reduced demand from final consumers because of lower factor incomes (also see below)

As was the case in South Africa, the relative importance of these effects on each industry will vary depending on how important each source of demand is to the industry and a variety of other GE factors.

Table 17: changes in Industry Output in Rest of Southern Africa (%)

AGRIC	0.27
EXTRACT	0.17
FOOD	0.63
LITMNFC	0.19
TECHMNFC	0.46
HVYMNFC	1.13
SVCES	-0.47
CGDS	-4.68

Source: qo from results file.

Capital goods sector and factor market effects

There is a considerable decline in production of capital goods in the rest of southern Africa. Production falls by 4.7% which is far greater than the impact in other regions. As a first order effect, we expect production of capital goods to decline since global savings are being reallocated to South Africa. However, this reallocation does not come close to fully explaining the impact on capital goods production in rest of southern Africa. The decline in capital goods production is explained primarily by two factors: the decline in the rental rate on capital and the increase in prices of goods which comprise capital goods.

Table 18 shows usage of factor services by sector in rest of southern Africa. The table illustrates that the services sector is the dominant sector in rest of southern Africa. It is the primary user skilled labor and capital services and an equivalent user of unskilled labor with agriculture. As shown above, output in the services sector falls. Even though output in other sectors is rising, the heavy use of factors in the services sector puts strong downward pressure on returns to skilled labor, unskilled labor and capital. Turning to capital goods, the decline in the rate of return to capital reduces the attractiveness of investment into the rest of southern Africa.

Table 18: Factor Use in the Rest of Southern Africa (shares)

	Land	Sk. Lab	Unsk. Lab	Capital	Nat. Res
AGRIC	100	2	41	15	
EXTRACT		1	4	14	100
FOOD		2	2	2	
LITMNFC		3	4	5	
TECHMNFC		2	4	5	
HVYMNFC		4	5	10	
SVCES		86	40	49	
Total	100	100	100	100	100

Source: Base GTAPview data array AG03.

At the same time, prices of goods used to create the composite capital good in rest of southern Africa are rising. Table 19 below illustrates the inputs into capital goods in the pre-simulation data base. A major input into capital goods production is techmnfc both domestic and imported. As shown above, the prices of domestic and imported techmnc rises by 0.4% and 0.9%. Thus, due to reduced rental rates on installed capital and increased prices for the major components of capital goods, capital goods production declines rather steeply in rest of southern Africa.

Table 19: Rest of southern Africa's capital goods sector: inputs and factor payments to capital

	Inputs	
	Domestic	Imported
AGRIC	35	2
EXTRACT	14	0
FOOD	0	0
LITMNFC	20	2
TECHMNFC	455	1019
HVYMNFC	15	11
SVCES	1087	45

Source: Base data arrays VDFA, VIFA, and EVFA.
Note that all flows are evaluated at agent's prices.

This impact on capital goods purchases is an interesting result from a modeling perspective, but is less appealing from a practical perspective, where many other factors are likely to influence investment, especially greater links between South Africa and the region, which can be expected to be a positive influence on investment returns. This could be (but in this experiment is not) modeled as an improvement in the investment climate in the rest of southern Africa, analogous to the improvement in South Africa.

Effects on the rest of the world

Because the other regions included in the model (the European Union, Sub-Saharan Africa, and 'the rest') are much larger than the rest of southern Africa, or have fewer trade linkages with South Africa, or both, the impacts on other regions are much smaller. Qualitatively they can be analysed in the same way as for the rest of southern Africa, but this is not done herein.

Possible Ideas for Extensions

1. Redesign shock
    - account for inflation
    - better proxy for RORE
2. Examine effects of changing RORFLEX parameter
3. Start from updated data to better reflect 'pre-shock' values
4. Calibrate shock to be consistent with actual outcomes (either by changing RORFLEX value or cgdstack shock)

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